

Lab Evaluation of AT584 Ammonia Sampler versus Reference Sampler

CR Manning, PhD, CIH

3-15-2011

1. Background

ANSI, OSHA, ASTM, and EC have all issued protocols for the evaluation of Diffusive Samplers (Personal Monitoring Badges) for measuring Time-Weighted-Average concentrations of contaminants in workers' personal breathing zones. Using the methodology described below, which is consistent with all known standards, samplers to be evaluated (Test Samplers) are placed in a laboratory chamber through which the test contaminant is circulated at a concentration in the vicinity of its permissible exposure limit. Reference Samplers are exposed to the same atmosphere for the same duration the Test Samplers. After an exposure of known duration, the Reference Samplers and Test Samplers under Evaluation are both analyzed and the results are compared statistically. The degree to which results for Test Samplers agree with results for Reference Samplers is the essence of the evaluation.

2. Personnel and Facilities

2.1 C.R. Manning, PhD, CIH; Stephanie Wong, BS, Kathy L. Taylor, BS

2.2 Generation of ammonia exposures was conducted at Assay Technology, Livermore, California (AIHA Accredited Lab #101728). Analysis of exposed samplers was performed at Assay Technology, Boardman, Ohio (AIHA Accredited Lab #100903).

3. Equipment

- 3.1 Miller-Nelson Atmosphere Generator HCS-501, 200 L/min (Assay Technology);
- 3.2 GuzBox III Exposure Chamber (4" x 4" x 12") coupled with polyethylene tubing;
- 3.3 Mass Flow Controller (Tylan);
- 3.4 Air Sampling Pump with four separate critical orifices, Check Mate (Assay Technology)
- 3.5 Reference Sampler - SKC Sampling Tube 226-10-06.

4. Plan of Study

- 4.1 A flow of pure air at 150 L/min generated using the Miller-Nelson Atmosphere Generator (50% RH, 25°C) and passed via polyethylene tubing to (and through) the Exposure Chamber.
- 4.2 Exposure Chamber fitted with axial fan to ensure air velocity near to 50 cm/sec.
- 4.3 Test Samplers placed in metal mesh baskets inside Exposure Chamber.
- 4.4 Chamber contained 4 sampling ports fitted with Reference Samplers.
- 4.5 Air Sampling Pump drew air through Reference Samplers at 25 mL/min.
- 4.6 Contaminant introduced by metering 10% certified ammonia gas from a cylinder to a Mass Flow Controller and through a shut-off valve and "T" joint into the flowing stream.
- 4.7 Exposures commenced by opening shut-off valve and actuating sampling pump.

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5. Results

Tabular results are shown below for three separate trials in which the AT584 Sampler was compared to a Reference Sampler in chamber exposures of 2 hour duration at or near to the PEL.

In Trial A, a single lot of 584 Samplers had a badge-to-badge variance (co-efficient of variation) of $\pm 1\%$ and agreed with the Reference Samplers to within $\pm 3\%$.

Table 1 - Ammonia Sampler Evaluation Trial A

Sampler Evaluation

23-Feb-10

Lab ID	Sampler (tube)	Analyte	Qty (μ g)	Sample Vol (L)	Time (min)	NH3 Conc (8hr TWA)	
						(mg/M3)	(ppm)
S754	J6-010-06	NH3	470	1.78	60	32.5	46.3
S755	J6-010-06	NH3	250	1.01	60	30.9	44.3
S756	J6-010-06	NH3	440	1.23	60	45.0	63.8
S758	J6-010-06	NH3	440	1.22	60	45.0	63.8
Co-Efficient of Variation =					20%	Ave =	54.5

Lab ID	Sampler (badge)	Analyte	Qty (μ g)	Sample Vol (L)	Time (min)	NH3 Conc (8hr TWA)	
						(mg/M3)	(ppm)
S751	J584 - 2G10-VS-1	NH3	430	1.35	60	39.8	56.6
S752	J584 - 2G10-VS-2	NH3	430	1.35	60	39.8	56.6
S753	J584 - 2G10-VS-3	NH3	420	1.35	60	38.9	55.3
Co-Efficient of Variation =					1%	Ave =	56.1
Variance versus Sampling Tube =						3%	

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In Trial B, two lots of 584 Samplers each had a badge-to-badge variance (co-efficient of variation) of $\pm 3\%$ and agreed with the Reference Samplers to within $\pm 2\%$.

Table 2 - Ammonia Sampler Evaluation Trial B

Sampler Evaluation 06-Aug-10

Lab ID	Sampler (tube)	Analyte	Qty (μg)	Sample Vol (L)	Time (min)	NH3 Conc'n (8hr TWA)	
						(mg/M3)	(ppm)
S878	Tube 226-10-06	NH3	780	3.01	120	65.0	92.5
S880	Tube 226-10-06	NH3	780	3.04	120	65.0	92.5
S881	Tube 226-10-06	NH3	680	3.08	120	55.0	77.5
S882	Tube 226-10-06	NH3	760	2.46	120	77.5	110.0
Co-Efficient of Variation =					14%	Ave =	93.1

Lab ID	Sampler (badge)	Analyte	Qty (μg)	Sample Vol (L)	Time (min)	NH3 Conc'n (8hr TWA)	
						(mg/M3)	(ppm)
S870	J584 - 6F10-1	NH3	680	2.7	120	63.0	89.5
S872	J584 - 6F10-2	NH3	680	2.7	120	63.0	89.5
S873	J584 - 6F10-3	NH3	720	2.7	120	66.7	94.7
Co-Efficient of Variation =					3%	Ave =	91.2
Variance versus Sampling Tube =					-2%		

Lab ID	Sampler (badge)	Analyte	Qty (μg)	Sample Vol (L)	Time (min)	NH3 Conc'n (8hr TWA)	
						(mg/M3)	(ppm)
S874	J584 - 7F10-1	NH3	680	2.70	120	63.0	89.5
S875	J584 - 7F10-2	NH3	720	2.70	120	66.7	94.7
S876	J584 - 7F10-3	NH3	680	2.70	120	63.0	89.5
Co-Efficient of Variation =					3%	Ave =	91.2
Variance versus Sampling Tube =					-2%		

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In Trial C, two lots of 584 Samplers had badge-to-badge variances (co-efficient of variation), respectively, of $\pm 3\%$ and $\pm 9\%$, and agreed with the Reference Samplers to within $\pm 1\%$ and $\pm 2\%$, respectively.

Table 3 - Ammonia Sampler Evaluation Trial C

Sampler Evaluation 22-Sep-10

Lab ID	Sampler (tube)	Analyte	Qty (μg)	Sample Vol (L)	Time (min)	NH3 Conc (8hr TWA)		
						(mg/M3)	(ppm)	
S227	Tube 226-10-06	NH3	360	2.92	120	30.0	42.5	
S228	Tube 226-10-06	NH3	340	2.44	120	35.0	50.0	
S230	Tube 226-10-06	NH3	330	2.62	120	32.5	45.0	
S231	Tube 226-10-06	NH3	190	1.32	120	35.0	50.0	
Co-Efficient of Variation =					8%	Ave =		46.9

Lab ID	Sampler (badge)	Analyte	Qty (μg)	Sample Vol (L)	Time (min)	NH3 Conc (8hr TWA)		
						(mg/M3)	(ppm)	
S217	10C09 - GZ0268	NH3	360	2.70	120	33.3	47.4	
S218	10C09 - GZ0250	NH3	360	2.70	120	33.3	47.4	
S219	10C09 - GZ0347	NH3	370	2.70	120	34.3	48.7	
S220	10C09 - GZ0158	NH3	370	2.70	120	34.3	48.7	
S221	10C09 - GZ0179	NH3	340	2.70	120	31.5	44.7	
Co-Efficient of Variation =					3%	Ave =		47.4

Variance versus Sampling Tube = **1%**

Lab ID	Sampler (badge)	Analyte	Qty (μg)	Sample Vol (L)	Time (min)	NH3 Conc (8hr TWA)		
						(mg/M3)	(ppm)	
S222	9G10 - HM0403	NH3	420	3.46	120	30.4	43.2	
S223	9G10 - HM0715	NH3	500	3.46	120	36.2	51.4	
S224	9G10 - HM0629	NH3	390	3.46	120	28.2	40.1	
S225	9G10 - HM0399	NH3	460	3.46	120	33.3	47.3	
S226	9G10 - HM0643	NH3	460	3.46	120	33.3	47.3	
Co-Efficient of Variation =					9%	Ave =		45.8

Variance versus Sampling Tube = **-2%**

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6. Discussion and Conclusions

In three separate trials, in a laboratory chamber environment, five separate groups of AT584 Personal Monitoring Badges provided values for Time-Weighted-Average ammonia exposure within $\pm 3\%$ of Reference Samplers.

The overall uncertainty of the measurement system is estimated to be within $\pm 13\%$ at a 95% confidence level.

From these data, we conclude that the AT584 Sampler is capable of accurately measuring time-weighted-average concentrations of ammonia within OSHA accuracy requirements in the vicinity of the OSHA Permissible Exposure Limit.